Raufoss Multipurpose Ammunition Technology Program, RMATS

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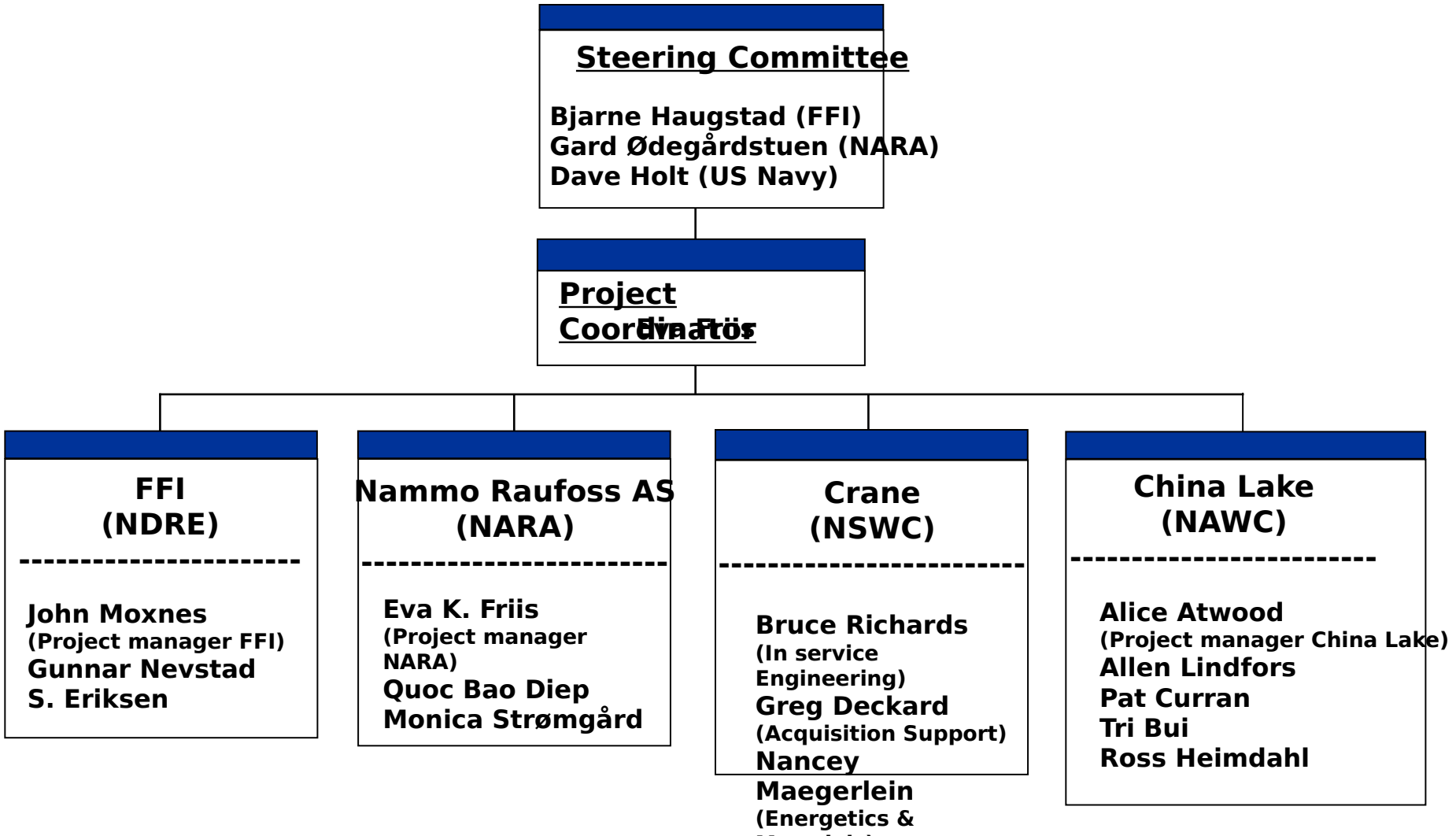
Topics

- Organization Chart
- Scope of Work
- Funding
- Computer Modeling
- Models compared to Actual
- Conclusions

Organizational Chart



Scope of Work

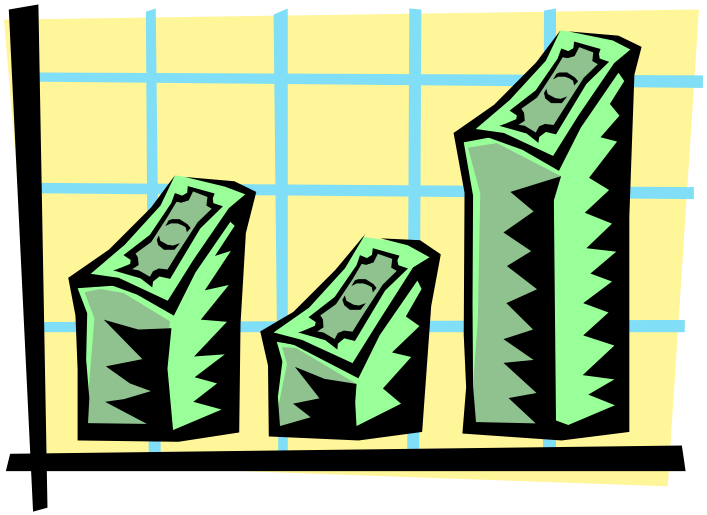
- **Phase I (1994 – 1999)**
  - **Provide and expand knowledge of MultiPurpose ammunition**
  - **Develop and validate numerical models for prediction of the events taking place when the ammunition is subjected to different stimuli**

- **Phase II (1999 – current)**
  - **Continue and refine the fundamental work done in Phase I**
  - **Product improvement with respect to safety, function, and manufacturing**
  - **Serve as an aid in resolving anomalous behavior of MP ammunition**

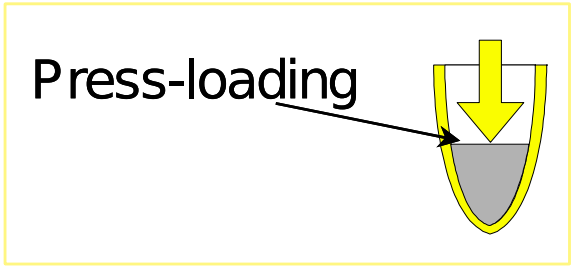
RMATS Funding

Funding for RMATS divided evenly between

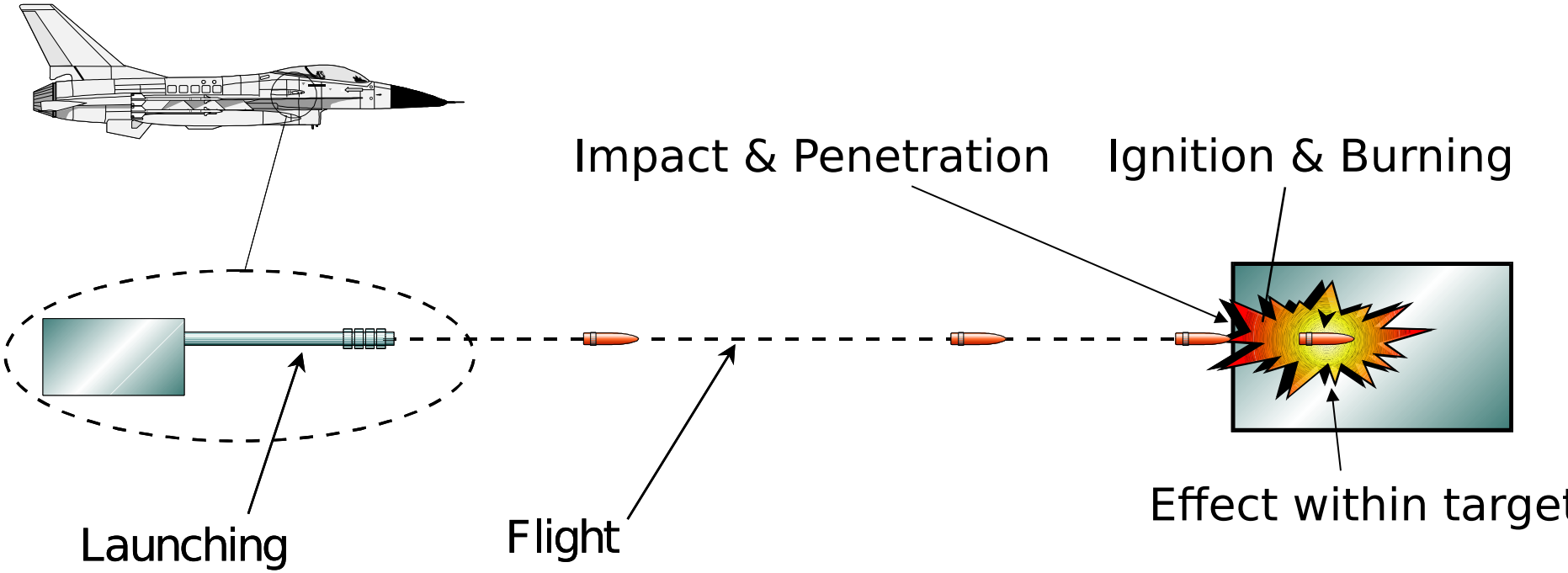
- **Norwegian MOD**
- **FFI (Norwegian Defense Research Establishment)**
- **Nammo Raufoss A/S (Manufacturing)**
- **US Navy (PMA-242)**



MP-Ammunition Technology Program



RMATS has validated models for manufacturing, ballistics, trajectory, and target function of the MP ammunition.



Computer Modeling

Why?

- **Effective tool to <u>design</u> ammunition**
- **Reliable method used to <u>predict</u> an event**
- **Efficient way to <u>study</u> an event**

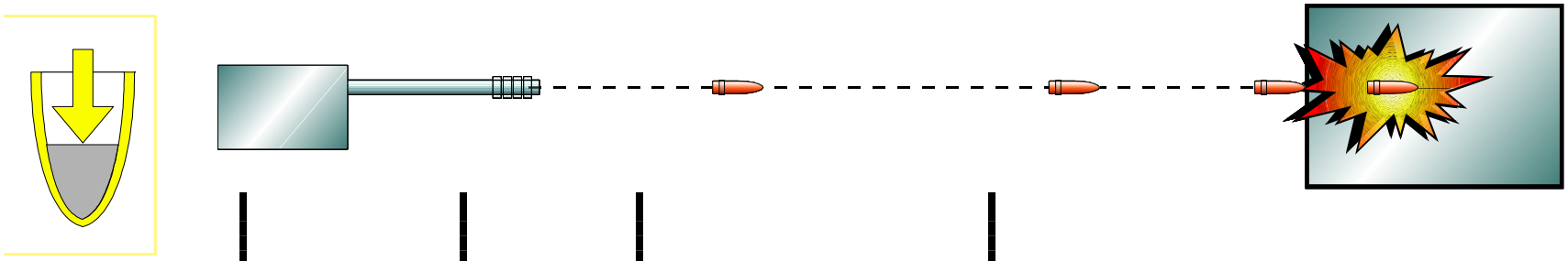
Prerequisites

- **Numerical code**
  - DYNA
  - Nike 2D
- **Material models**
  - metals
- **Material data**
  - steel
- **Physical models**
  - ignition model
- **Initial conditions**
  - Velocity
  - Temperature
  - Pressure

Research Procedure

1. **Physical Experiments**
2. **Reduction of experimental data**
3. **Establish mathematical models and material data**
4. **Implement mathematical models into numerical code**
5. **Model experiments**
6. **Validate model by comparing physical experiments to computations**

Experiments to describe MP Function



Manufacture Launch Flight Target Impact
Fragmentation and Burn.

Mechanical Properties	**Mechanical Thermal Properties**	**Shock Mechanical Thermal Combustion**	**Combustion Fragmentation Mechanical Thermal Properties**

Properties

Formulation of Models

- Validated mathematical/physical models and material data are of vital importance to obtain reliable results
- Advanced laboratory experiments were required to establish and test models and material data
- The laboratories at China Lake, FFI and Nammo Raufoss have succe rformed experiments which were n

Experiments

- **The laboratories at China Lake played a major role in testing of the energetic materials used in the MP ammunition**
- **Tests performed:**
  - Piston driven compaction (PDC)
  - Flyer plate experiments
  - Thermal ignition
  - DSC and TGA
  - Hot-stage microscopy
  - Closed bomb tests
  - Quasi-Static Compaction (Press loading apparatus)
  - Expanding ring test

Numerical Simulations

Loading forces
&
initial velocities

Material geometry

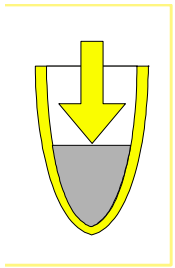
Material models
- metal parts
- incendiary & HE
- target

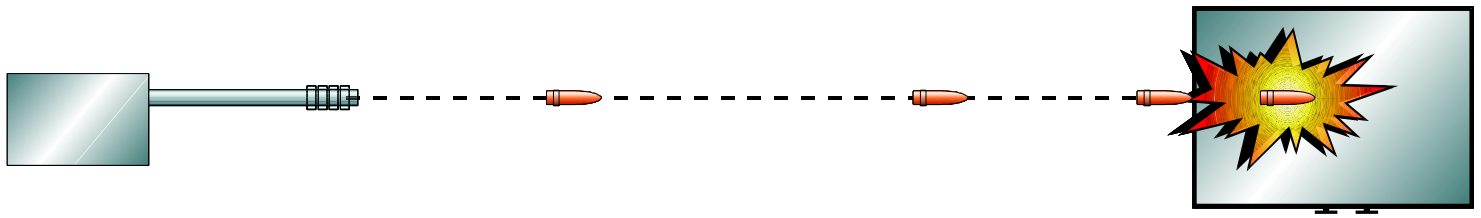
Numerical parameters

Interactions

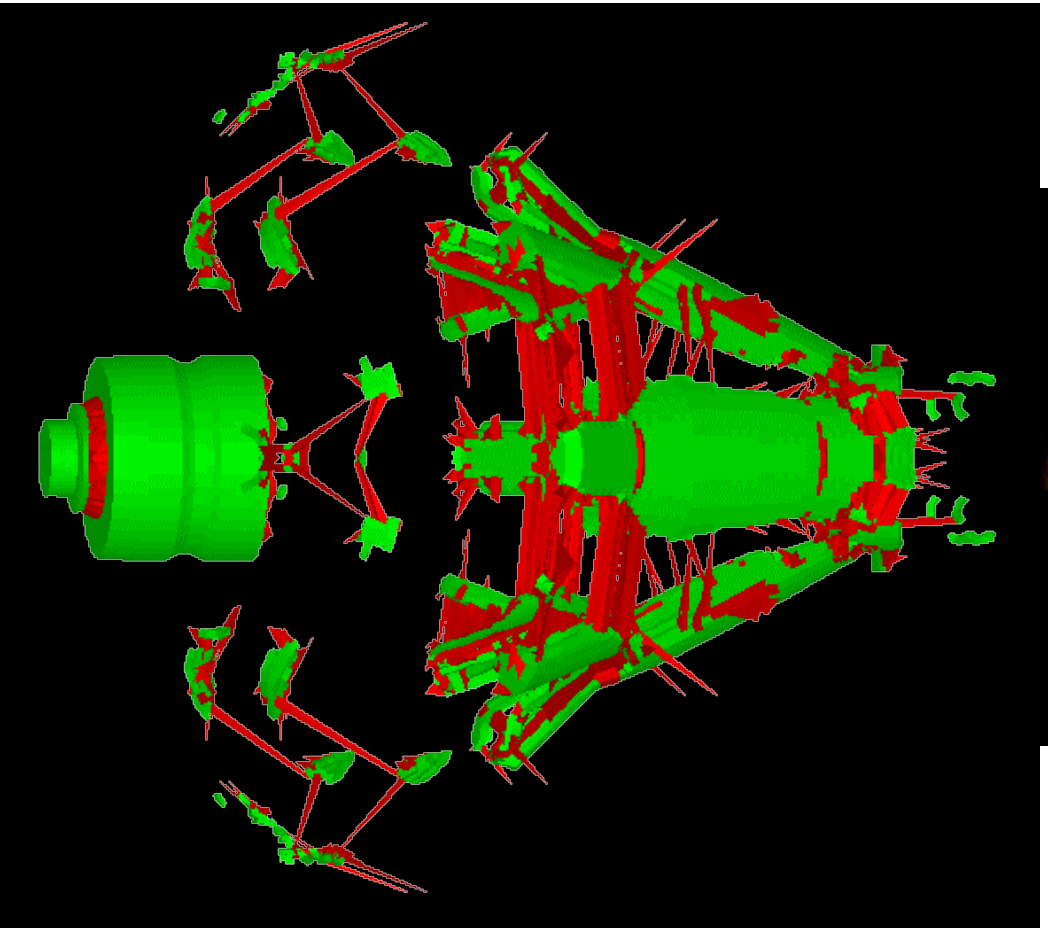
Numerical code

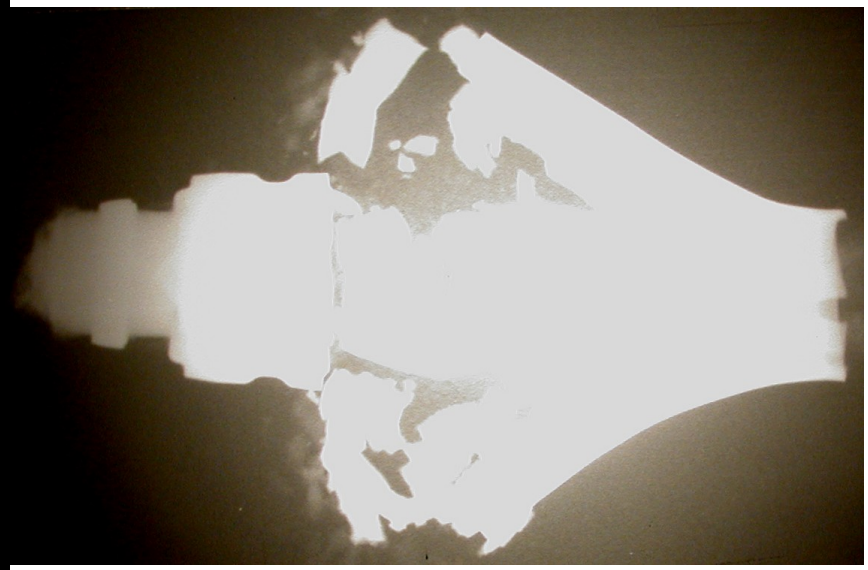
OUTPUT
- press-filling operation
- launching effects
- flight effects
- initial condition (prior to impact)
- impact & penetration (course of events)
- ignition stimuli
- burning
- fragmentation



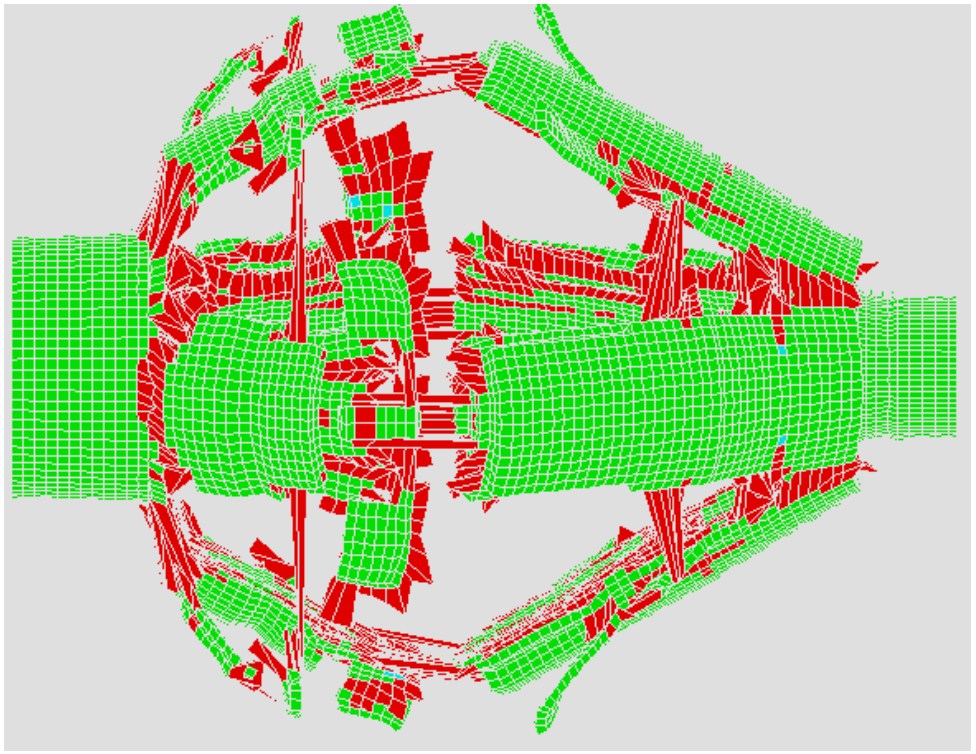


Comparing the Simulation with the Experiment
30 mm MP



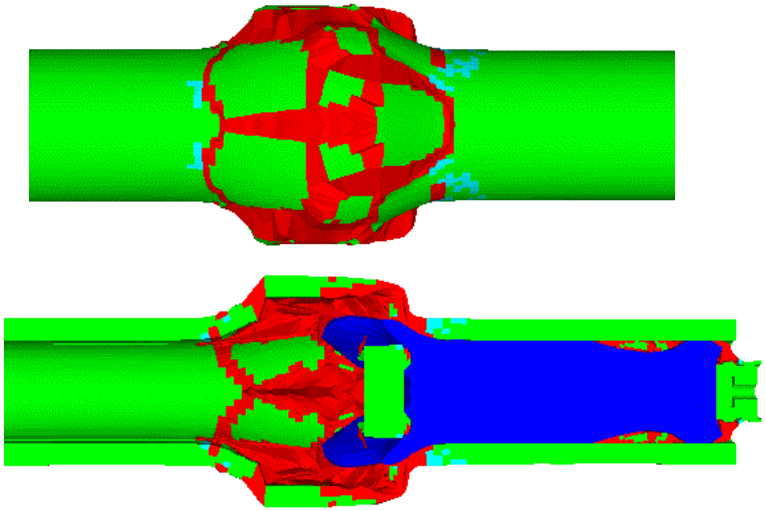


Comparing the Simulation with the Experiment
20 mm MP



Results of modeling 20mm M61 barrels

Simulation:



Simulations where the PGU 28/B is set off while the round is moving (dynamic situation).

Experiment:

Barrel damage as a result of the experime
of a dynamic function of the PGU 28/B rou
in the thin region of the barrel.

Conclusions

- RMATS has established a suite of validated models to evaluate all phases of the ammunition life cycle
- Collaboration between all parties involved with RMATS has provided benefits in many areas
  - Manufacturing
  - Ballistics
  - Target Function
  - Engineering Investigation
- The RMATS team encourages participation from all DoD related organizations